



# 1999–2000 CATS ASSESSMENT

## Open-Response Item Scoring Worksheet

### Grade 11 – Science

The **academic expectation** addressed by the open-response item “Dating Rock Layers” is

2.2 Patterns—Students identify, analyze, and use patterns such as cycles and trends to understand past and present events and predict future events.

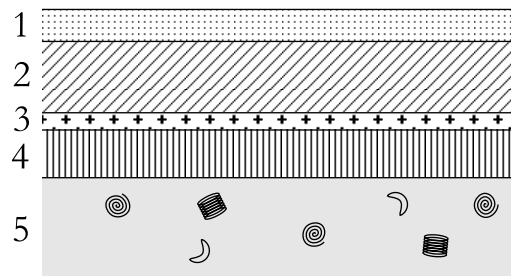
The **core content** addressed by this item includes:

The Formation and Ongoing Changes of the Earth System

- Techniques used to estimate geologic time include using radioactive dating, observing rock sequences, and comparing fossils to correlate the rock sequences at various locations.

#### Dating Rock Layers

Use the diagram below to answer the question.



The diagram above shows 5 rock layers. You have been asked to determine the age of rock layer 5. Two measures of geologic time are absolute time, which relates to the year something happened, and relative time, which relates to the order or sequence in which events occurred.

- Describe **three** methods that could be used to determine the age of the rock layer. One of the three methods should be a method for determining **relative time**. One of the three methods should be a method for determining **absolute time**.
- How will these methods identify the age of the rock layer?



# SCORING GUIDE

## Grade 11 Science

Score	Description
4	The response is complete and shows an in-depth understanding of relative and absolute time and how they are used to determine the age of rocks. There is an accurate description of three methods of dating rocks, including how the methods identify the rocks' age. The description includes one method for determining relative time and one method for determining absolute time.
3	The response shows an understanding of relative and absolute time and how they are used to determine the age of rocks. There is a description of two or three methods of dating rocks, including how the methods identify the rocks' age. The description includes one method for determining relative time and one method for determining absolute time, or two detailed descriptions for one type of dating; however, the response may lack detail or contain minor errors or misconceptions.
2	The response shows a limited understanding of relative and absolute time and how they are used to determine the age of rocks. The description includes one method for determining the age of rocks in detail or lists two or three methods with little or no explanation; however, the response contains errors, misconceptions, and omissions.
1	The response is incomplete and shows minimal understanding of relative and absolute time and how to determine the age of rocks. A method of dating rocks is described; however, the description contains major errors, misconceptions, and omissions.
0	Response is totally incorrect or irrelevant.
Blank	No response.

### Example Student Response:

One way to determine its relative age is to see what rock layers are above it. In most cases you can say that the rocks on the bottom are older than the layers of rock on top of it. For absolute age you could take rock samples from that layer and date the fossils that are found there or you could do Carbon-14 dating. This would tell you how old it is.

### Science Behind the Question:

Both relative and absolute time are needed to read a rock record.

- Relative time places events in a sequence but does not identify their actual date of occurrence. The **law of superposition** states that in a series of undisturbed sedimentary rock, the oldest layer is on the bottom and the youngest on the top. The **law of cross-cutting relationships** states that an igneous rock is younger than the rocks it has intruded. The **law of included fragments** states that pieces of one rock found in another rock must be older than the rock in which it is found.
- Absolute time identifies the actual date of the event. Three methods used for determining this are radioactive dating, fossil correlation, and rock layer sequencing by observation or core sampling. Comparison to events that have known dates (such as volcanic eruptions) can also be employed.

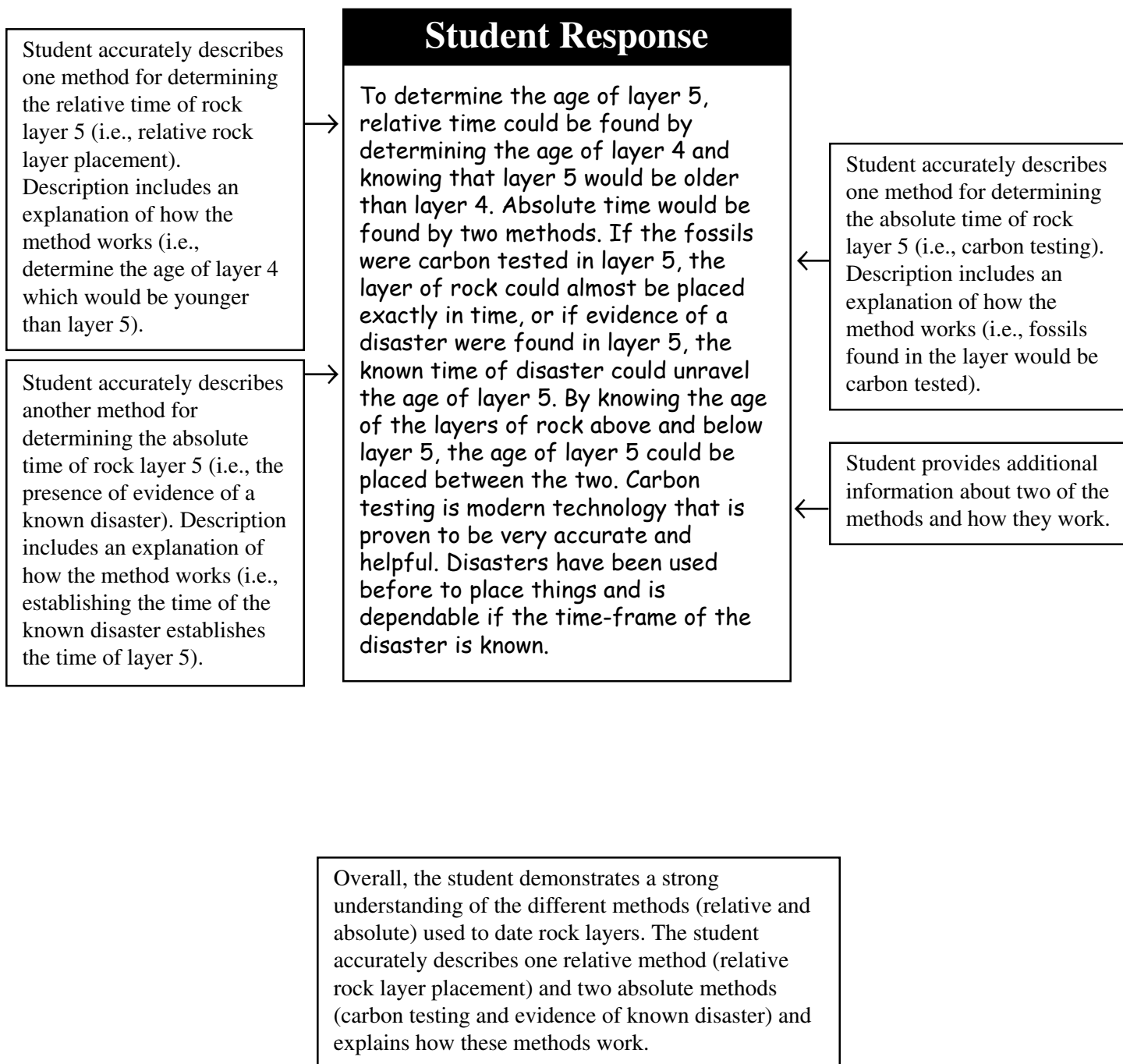
Although carbon-14 dating method is limited to about 50,000 years and so is not usable for most rocks, students will mostly be unfamiliar with other radioactive methods (uranium-lead, rubidium-strontium, potassium-argon), so the carbon method is accepted as representative of radioactive decay methods.



# ANNOTATED STUDENT RESPONSE

## Grade 11 Science

### Sample 4-Point Response of Student Work





# ANNOTATED STUDENT RESPONSE

## Grade 11 Science

### Sample 4-Point Response of Student Work

#### Student Response

A. A method of finding the relative time would be to think logically about the layers. if layer 5 is below layer 4, layer five was formed before it. Then layer 4 was formed, then 3, then 2, then 1. A way to find absolute time would be to use carbon aging. You can take carbon readings of old artifacts and such, and find almost exactly how old it is. A different way to determine the age of the rock layer would be to look for fossils, remains, or artifacts in each layer and study them.

B. The first method really wouldn't help you find how old it was to an exact date but it would help you determine the order therefore knowing layer 5 is older than layer 4 and so on. I don't know how to find the carbon readings exactly but I do know by finding them you can have a pretty accurate idea of what time period an object is formed. By finding artifacts and remains you could find out when the layer is from. For instance, if you found a tablet with Latin writing on it you would know it was from the Roman Era.

← Student accurately describes three methods for determining the age of rock layer 5 (i.e., relative rock layer placement, carbon readings, study of fossils). Description includes one relative method and two absolute methods, as well as an explanation of how these methods work.

← Student provides additional information about how each of the three methods works (e.g., “if you found a tablet with Latin writing on it you would know [the layer] was from the Roman Era”).

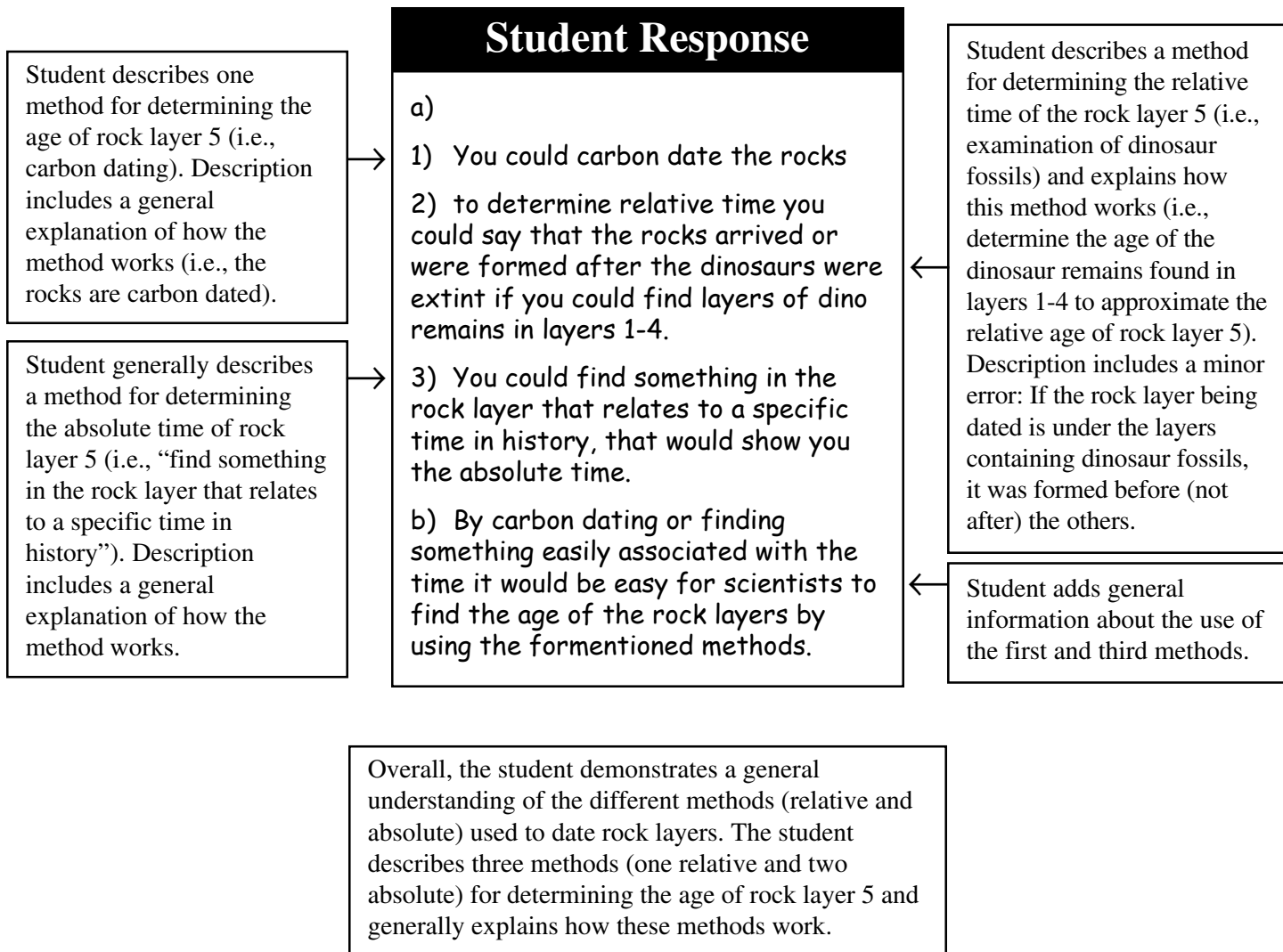
Overall, the student demonstrates a strong understanding of the different methods (relative and absolute) used to date rock layers. The student accurately describes one relative method (relative rock layer placement ) and two absolute methods (carbon readings and study of artifacts) and explains how these methods work.



# ANNOTATED STUDENT RESPONSE

## Grade 11 Science

### Sample 3-Point Response of Student Work





# ANNOTATED STUDENT RESPONSE

## Grade 11 Science

### Sample 2-Point Response of Student Work

#### Student Response

Rocks have been around for a long time in the idea of dating rocks is not an easy task as you are or have many different ways that you can choose to determine how old a rock is such as looking at the markings on a rock and the size of a rock and the texture of the rock this will not be able to get you an absolute date of the rock but you will be able to know around how long that this rock has been on the earth.

If you were to try and find out the absolute date of the rock you would have to break the rock and do a serious amount of testing on the rock in a lab or in a science place as something like that. In ageing of the rocks layers you are to look and you will automatically know that the age of the longest time will be the rock the nearest to the bottom because the rock has already been formed and you will know that the lowest part would be the oldest in the years of the Rocks age.

← Student describes one method of determining the age of a rock (i.e., examination of a rock's characteristics). This method is partially correct (i.e., some rocks do have layers that can be used for dating purposes), but the description lacks detail.

← Student describes a second method of determining the age of a rock (i.e., break the rock and "do a serious amount of testing on the rock in a lab"). The description lacks detail (e.g., the description does not describe the types of tests that should be done).

← Student accurately describes a third method of determining the age of a rock layer (i.e., relative rock layer placement), although the description is somewhat unclear.

Overall, the student demonstrates some understanding of the different methods (relative and absolute) used to date rock layers. The student accurately describes one method (relative rock layer placement) and attempts to describe two other methods but the descriptions both lack detail.



# ANNOTATED STUDENT RESPONSE

## Grade 11 Science

### Sample 1-Point Response of Student Work

#### Student Response

Three methods that determine the age of the rock layer include how wide it is. All the other layers are skinnier than this one. This layer is on the bottom so it's pretty old.

← Student attempts to describe one method for determining the age of rock layer 5 (i.e., determine “how wide it is”), but the method is incorrect.

← Student correctly states that “[layer 5] is on the bottom so it’s pretty old.”

Overall, the student demonstrates a minimal understanding of the methods (relative and absolute) that can be used to date rock layers by correctly stating that layer 5 is older than the other layers above it.



# INSTRUCTIONAL STRATEGIES

## Grade 11 Science

The open-response item **“Dating Rock Layers”** was designed to address students’ understanding that different techniques can be used to estimate geologic time. The instructional strategies below present ideas for helping students explore and master this concept.

Discuss the following concepts and terms with students:

- geologic time and the geologic time scale
- techniques used to estimate geologic time, including radioactive dating, observing rock sequences, and comparing fossils to correlate rock sequences
- principle of uniformitarianism—geologic processes that we observe today are the same processes that were at work in the past
- rock strata
- law of superposition—an undisturbed or undeformed sedimentary rock layer is older than the layers above it
- types of unconformities
- law of crosscutting relationships—a fault or intrusion is always younger than the rock layers that it invades
- rock records—rocks contain evidence about Earth’s past, including evidence of ancient life-forms; the use of rock record information helps us understand geologic processes and how life has evolved
- radioactive decay and half-life
- varves
- index fossils

Provide opportunities for students to work individually, in pairs, in small groups, and/or as a class to complete (with teacher guidance and support) any or all of the following activities:

- Investigate geologic time by constructing a physical scale model that shows subdivisions of geologic time. Include descriptions of geologic and atmospheric changes and biologic evolution. Describe patterns of changes throughout geologic time.
- Use the Internet to visit the following web site: <http://www.ucmp.berkeley.edu/fosrec/McKinney.html>. Use small candies and graph paper to develop a model to explain half-life. Explain how half-life is used in absolute dating of rocks and other materials.





# INSTRUCTIONAL STRATEGIES

## Grade 11 Science

- Use a geologic map of Kentucky to identify rock sequences and the distribution of fossil types across the state. Identify the age of rocks in the area around your school. Use the Internet to visit the Kentucky Geological Survey web site: <http://www.uky.edu/KGS/education/agedating.html>. Explain how geologists likely determined the ages of these rocks. Create displays to explain how the area around your school has changed throughout geologic time.
- Gather information about fossils in different geographic areas of Earth. Compare these to fossils found in different Kentucky regions.
- Identify Kentucky's state rock, mineral, and fossil and explain how each of these formed. Create educational brochures to promote Kentucky's state rock, mineral, and fossil. Distribute the brochures at visitor centers.
- Examine maps to identify coal deposits in Kentucky. Develop presentations to explain how coal forms.
- Explore how movement of continental plates affected distribution of species. Investigate how scientists match fossils and rock formations across plate boundaries, the unique collection of species on some continents (e.g., marsupials in Australia), and the distribution of biogeographical realms.
- Develop a model to demonstrate how varves are formed. Explain how varves are used in relative dating.